4000 years of climate change in Northern Spain from speleothem records

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Coetaneous stalagmites from three different caves in N. Spain (Ojo Guareña, Atapuerca and Cobre) have been investigated in order to reconstruct the regional paleoenvironmental conditions related to the North Atlantic climatic variability through the last four millennia. This reconstruction, based on a multi-proxy approach which includes oxygen and carbon isotope profiles and microfacies analysis, has been calibrated by means of present-day hydrogeochemical monitoring programs of the environment of the caves as well as historical archives in the area.

The investigated caves, located inland Spain, show significantly different local climatic conditions, ranging from the high-mountain climate of the Cantabrian Ranges (Cobre Cave) to the drier and warmer climate of the Meseta (Atapuerca), and are thought to be strongly sensitive to medium to long-term NAO oscillations.

Comparative analysis of the reconstructed series demonstrates an overall correspondence which allows establishing the regional pluvio-thermal changes at decadal to millennial scales for the 4000 years, but also notable differences that are attributed to local or karst-related factors. Spectral analysis of stable isotope values yields significant periodicities that could correspond to known solar cycles, supporting the idea that long-term NAO changes strongly respond to solar forcing.

Also, comparison of geochemistry of recent and ancient espeleothems reveals quite unique, extreme climate conditions for the last years, related to 20th Century global warming. Comparable conditions to those of today were reached only during few, relatively short intervals, throughout the last four millennia in N Spain.

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